IV. THE SKYBRIDGE SYSTEM WILL FULLY PROTECT GSO FSS AND BSS SYSTEMS AND TERRESTRIAL FS SYSTEMS.

As noted above, the sole issue presented by the Petition is the merit of the rules proposed by SkyBridge to allow generic NGSO FSS systems to operate co-frequency with GSO and FS systems. The efficacy of these rules depends solely on the parameters of such GSO and FS systems. Nonetheless, several commentors chose instead to raise issues related to the particular characteristics of the SkyBridge System. SkyBridge takes this opportunity to address these concerns.

A. The SkyBridge System will fully protect existing FS links, and will not significantly inhibit expansion of FS networks.

1. Long term and short term I/N.

TIA challenges the I/N levels computed by SkyBridge in Exhibit C of the Amendment.[43/] The alleged discrepancies in SkyBridge's methodology cited by TIA are addressed below.

Item 1: Noise level

TIA states that SkyBridge should have used a receiver thermal noise floor of -140 dB(W/MHz) (per ITU-R Rec. F.758) instead of -136 dB(W/MHz).[44/] In fact, SkyBridge has used the same noise level as specified in ITU-R Rec. F.758; however, the noise was taken into account at a different point in the line from the antenna to the FS receiver. The -140 dB(W/MHz) figure represents the receiver system noise level as seen at the receiver input (point A in the figure below), while the -136 dB(W/MHz) figure represents the receiver system noise level as seen at the

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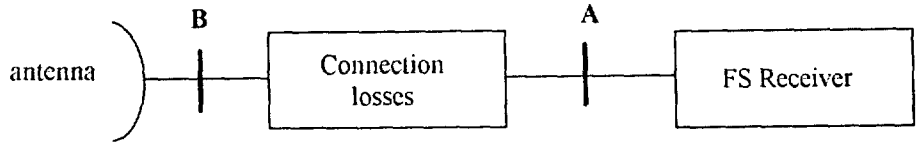
43/ TIA Comments at 9-10; Harris Comments at 3. See Amendment at C-18-19.

44/ TIA Comments at 9, 10.

antenna output (point B in the figure below). The difference between the two values (4 dB) is simply the value of the connection losses.[45/] Connection losses were not separately included in the SkyBridge analysis; as explained in note 4 of Exhibit C to the Amendment, these losses were already included in the receiver thermal noise floor value.



Item 2: FS antenna gain

For the short term calculations, TIA states that SkyBridge should have used an on-axis antenna gain of 51 dBi, a number that appears only in a yet-to-be adopted draft revision ITU-R Rec. F.758.[46/] At present, F.758 proposes several sets of FS characteristics for the subject bands, including antennas with a gain of 47 dBi.

[45/] More precisely, if T_r is the FS receiver temperature (438 K for the FS reference case, corresponding to a 4 dB noise figure of the receiver); T_a is the FS antenna temperature (290 K); L_f are the connection losses (4 dB for the FS reference case as defined by SkyBridge); and T_o is the reference temperature (=290 K), then:

The system noise temperature T_A at the point A is:

$$T_A = T_a/L_f + T_o (1 - 1/L_f) + T_r = 728 \text{ K}$$

The system noise temperature T_B at the point B is:

$$T_B = T_a + T_o (L_f - 1) + T_r L_f = 1827 \text{ K}$$

The difference between these values is 10 log(1827/728) or 4.0 dB, which is the difference between TIA's -140 dBW/MHz and SkyBridge's -136 dBW/MHz.

[46/] TIA Comments at 10.

Using this number, calculations would place the SkyBridge signal approximately 0.4 dB above the target I/N threshold apparently favored by TIA, an immaterial variation that would cause no measurable increase in FS signal degradation (even using TIA's suggested 51 dBi does not significantly affect this result). More importantly, after discussion with U.S. FS operators and FS manufacturers, it was determined that a typical FS antenna gain of 45 dBi is most appropriate, and that is what was used in the SkyBridge analysis.

Item 3: Long term definition

The long term situation is modeled in Exhibit C of the Amendment by the contributions from three SkyBridge Satellites at a 40° off-axis angle from the FS receiver. TIA has erroneously used three Satellites at a 10° off-axis angle.[47/] Three SkyBridge Satellites cannot be seen simultaneously at 10° off-axis; at any given time only a single satellite can be seen in the 10° cone around the boresight of the antenna of a particular FS receiver, no matter where it is located on Earth.

Item 4: Adjacent channel interference

Finally, TIA states that, because the signals will not be Nyquist filtered, adjacent channel interference should be taken into account, increasing I/N by another 3 dB.[48/] This is not correct. The waveform employed by the SkyBridge System generates a flat spectrum over the bandwidth used for the signal transmissions. The power levels indicated in the Application and Amendment are

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[47/] TIA Comments at 8-9.

[48/] TIA Comments at 10. It is assumed that the "adjacent beam" concern raised by TIA with respect to the short term computations is the same as the "adjacent channel" concern it raised with respect to the long term analysis.

those effectively generated over the entire spectrum used by the SkyBridge System. Therefore, interference levels from adjacent channels do not have to be added.

The impact of the four above points is summarized in the following long term and short term I/N computations, based on the "reference cases" in Tables C-13 and C-12, respectively:

Long Term		**SkyBridge**	**TIA**
	Satellite On-axis EIRP for Gateway Link (dBW)	-3.5	
	Contribution from 3 Spots (dB)	+4.8	
	Path Loss (at 12 GHz) (dB)	-177.3	
Item 3	Off-axis FS Antenna Gain[49/] (dBi)	-6 (@40°)	+17 (@8°)
	Bandwidth (2.93 MHz) (dBMHz)	-4.7	
Item 4	Adjacent Channel (dB)	0	+3
Item 1	Connection Losses (dB)	0	-4
	Interference Power Density (I) (dB(W/MHz))	-186.7	
Item 1	Noise Power Density (N) (dB(W/MHz))	-136	-140
	I/N (dB)	**-50.7**	

[49/] There was an unintentional error in Table C-13 of the Amendment. The fourth row should be deleted, and the fifth row should provide the off-axis FS antenna gain (rather than off-axis satellite antenna loss) at 40° elevation using Rec. ITU-R F.699 for a 45 dBi antenna.

Short Term		SkyBridge	TIA
	Satellite On-axis EIRP for Gateway Link (dBW)	-3.5	
	Traffic Shedding (dB)	-3	
	Off-axis Satellite Antenna Loss (dB)	-2	
	Path Loss (at 12 GHz) (dB)	177.3	
	Difference in Path Losses (dB)	-2.1	
Item 2	On-axis FS Antenna Gain (dBi)	45	51
	Bandwidth (2.93 MHz) (dBMHz)	-4.7	
Item 4	Adjacent Channel (dB)	0	+3
Item 1	Connection Losses	0	-4
	Interference Power Density (I) (dB(W/MHz))	-147.6	
Item 1	Noise Power Density (N) (dB(W/MHz))	-136	-140
	I/N (dB)	**-11.6**	
	Probability of Occurrence	**10^{-5}**	

The above computations fully resolve the discrepancies between the TIA and SkyBridge long term and short term computations, and confirm the completely benign characteristics of the SkyBridge System.

2. FS expansion.

TIA has challenged the separation distance calculations presented in Exhibit C of the SkyBridge Amendment.[50/] The calculations disputed by TIA appear to be those assessing the power received by FS receivers from SkyBridge Gateways (and not those directed to the impact of FS on SkyBridge, as stated by TIA on page

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[50/] TIA Comments at 3, 5-6, 7-8.

11 of its comments). TIA calculates the interference from SkyBridge to FS systems to be 61 dB worse than that calculated by SkyBridge.[51/]

Two of the reasons for the discrepancy have already been explained above. Briefly, a 4 dB discrepancy can be attributed to the reference point in the FS receiver line at which I/N is calculated (Item 1 above). In addition, a 6 dB discrepancy can be attributed to the difference in the antenna gain considered for the FS receiver (Item 2 above).

The remaining difference comes from the fact that SkyBridge has assumed that the Gateway could be sited at 25° off-axis from the FS receiver pointing direction, dictating an FS receiving antenna gain of -6 dB, instead of the FS on-axis gain used by TIA. It is always possible to hypothesize a situation in which SkyBridge Gateways cannot be sited at a particular location (e.g., in the path of an FS link). The studies provided by SkyBridge in Section IV of Exhibit C of the Amendment show that there is always a way to site Gateways so that FS expansion is not materially affected, even in dense FS areas. These studies take into account both FS-to-FSS impact and FSS-to-FS impact.

SkyBridge Gateway siting at 25° off-axis from the FS pointing direction leads to separation distances of about 10 km,[52/] instead of the 160 km

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[51/] TIA Comments at 11.

[52/] See Amendment at C-21-22.

claimed by TIA.[53] Through the use of RF fences or proper siting, the 10 km separation distance can be substantially reduced.

3. Other FS protection issues.

Certain other concerns related to FS operation were raised in the comments. TIA asked how SkyBridge will use the 14.4-14.5 GHz band for its User Terminals in Regions 1 and 3, where this band is sometimes used for FS systems.[54] In fact, as indicated in Figure 3 of the Amendment, the ubiquitous residential User Terminals will only be employed in the 14.0-14.3 GHz portion of that band. Worldwide, this sub-band is very lightly used by FS systems.[55] As indicated in Figure 3 of the Amendment, Professional User Terminals may be employed in 14.3-14.5 GHz band in some countries where there is no FS assignment.

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[53] TIA Comments at 12; Harris Comments at 3. It should be noted that, using the propagation model described below, the 194.6 dB loss found by TIA corresponds to a 55 km coordination distance for a Gateway and an FS station 20 m above ground, which is far below the 160 km value cited by TIA.

Propagation model:
- free space loss for FS in visibility
- spherical diffraction (following Rec 526-2) for medium distances
- tropospherical diffraction (following Rec 452-5) for long distances

[54] TIA Comments at 3, 7.

[55] The 14.0-14.3 GHz is allocated to the FS only in the countries listed in Radio Regulations footnote S5.05. The 14.25-14.3 GHz band is allocated to the FS only in countries listed in footnote S5.508, and, as far as Europe is concerned, FS operation in this band is decreasing considerably in favor of FSS operations. Furthermore, the International Frequency List gives a good indicate of very light usage: No FS stations are notified within the 14.0-14.25 GHz band, and very few are notified within the 14.25-14.3 GHz band.

TIA also expressed doubt that the 17.7-17.8 GHz band can accommodate another satellite system.[56/] Because SkyBridge will apply the same mitigation techniques in both the 17.7-17.8 GHz band and the 10.7-11.7 GHz band, the protection of FS systems will be the same in both bands. Therefore, separate studies were not shown in the Application and Amendment.

TIA also claimed that a frequency guard band may be necessary near 11.7 GHz to protect FS links from SkyBridge User Terminals.[57/] As far as the SkyBridge downlink is concerned, the transmission from the Satellites will meet the ITU and FCC out-of-band requirements, as stated in the Application. With regard to the possibility of interference to SkyBridge from FS transmissions into SkyBridge User Terminals operating near 11.7 GHz, SkyBridge has included features in the User Terminal design to avoid this problem.

TIA further argues that FS operators do not distinguish between short term and long term interference, and, therefore, the long term criteria should be controlling.[58/] TIA notes that SkyBridge short duration interference events would not meet the long term criteria by 11.4 dB, according to TIA's calculations, which have been shown above to be incorrect.[59/] From the calculations presented in the Amendment, as further explained above, it can be seen that the I/N ratio is always

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[56/] TIA Comments at 3, 6.

[57/] TIA Comments at 6.

[58/] TIA Comments at 10-11; Harris Comments at 3.

[59/] TIA Comments at 10; Harris Comments at 3.

less than -6 dB, and even less than -10 dB, which means that the long term criteria is fully met 100% of the time.

PanAmSat dedicates a portion of its "preliminary" technical analysis to a series of citations to various ITU documents that relate, in a very generic sense, to FSS/FS coordination. However, on their face, none is particularly relevant to an understanding of the issues presented either by the basic concept of NGSO/FS sharing or the specific parameters of the SkyBridge System.[60/]

First, PanAmSat states that further study is required to determine the impact of NGSO systems to availability requirements, as specified in ITU-R F.1241.[61/] However, with regard to interference from FSS systems, as long as the protection levels described in Rec. ITU-R F.758[62/] are met, there is no need to look further into the performance requirements. These protection levels have been defined to meet the performance levels described in F.1241. It is only in the case where the limits are exceeded that a more precise analysis must be performed using all the characteristics of the FS, e.g., nature of the ground below the FS path, altitude of the transmitters and receivers, etc. This situation is not present here.

60/ PanAmSat also argues that the SkyBridge short term interference to FS systems is "barely within acceptable limits." Id. For the FS, the short term situation occurs even less frequently than in the GSO situation (see Section IV.B) -- 0.001% of the time -- and leads to a 7% noise temperature increase, corresponding to a 0.29 dB C/N loss. These values are approximately 30 dB below the value defined in ITU-R 847. PanAmSat's characterization of these margins as "barely acceptable" is patently absurd.

61/ PanAmSat Comments at A-4.

62/ Two levels of I/N are proposed in F.758: a conservative reference I/N of -10 dB, and a possible use I/N of -6 dB.

Second, PanAmSat states that the methodology in ITU-R IS.1143 for evaluating the effect of p.f.d. levels on the FS from NGSO MSS satellites may be helpful for evaluating the impact from NGSO FSS systems;[63/] IS.1143 evaluates the effect of p.f.d. levels in terms of Fractional Degradation of Performance ("FDP"), as developed in ITU-R F.1108. However, IS.1143 is inapposite on its face. It relies on parameters for NGSO MSS and FS systems operating between 1 and 3 GHz only; IS.1143 simply has no applicability to an NGSO FSS system operating at Ku-band.[64/]

On the other hand, F.1108 does provide the necessary tools to evaluate the FDP for any NGSO system, and SkyBridge agrees that this method is applicable here. In fact, as summarized in Exhibit B of the Application, studies have been performed in order to assess the effect of the p.f.d. of the SkyBridge satellites in terms of FDP.[65/] These studies have shown that the FDP on FS receivers produced

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63/ PanAmSat Comments at A-5.

64/ PanAmSat also suggests (at A-6) that Resolution 46 (WRC-95) of the ITU's Radio Regulations is relevant to the instant proceeding. Res. 46 provides an interim procedure (in Annex 1) for notification and coordination of frequency assignments of NGSO networks, applicable to certain frequency bands only, e.g., for NGSO MSS feeder or service links and a few NGSO FSS systems like Teledesic. The hard limits in Res. 46 deal with p.f.d. only. PanAmSat does not seem to understand that Res. 46 involves a coordination procedure on a system by system basis, which is totally impractical in the Ku-band, as it is heavily used by GSO systems. The hard limit concept proposed by SkyBridge offers GSO operators higher protection than that resulting from a coordination negotiation.

65/ Note that the FDP provided in Exhibit B was computed using the p.f.d. mask defined in Section 25.208 of the Commission's rules, and not the real p.f.d. radiated by SkyBridge Satellites, which results in much lower values.

by SkyBridge emissions is always significantly below 10%, which is usually the maximum FDP level for ensuring the protection of FS receivers.

B. The SkyBridge System will cause no noticeable degradation to GSO FSS and BSS systems, and will impose no operational constraints on operators of such systems.

1. Long term and short term interference levels.

No FSS operator has claimed that the long term interference levels contained in the SkyBridge interference analysis of the Application and Amendment would cause noticeable degradation to its system. One commentator, PanAmSat, argued that the short term levels, however, "give cause for concern."[66/]

PanAmSat argues that SkyBridge short term interference into GSO systems calculated in Exhibit C of the Amendment is barely acceptable.[67/] As noted in PanAmSat's own comments, the I/N value corresponds to a 2% thermal noise increase. Thus, for at most 0.3% of the time, a 0.09 dB loss in the C/N will be experienced, which is not measurable. It is inconceivable that such short term levels could be considered unacceptable by PanAmSat or anyone else.

AMSC suggests that its GSO feeder links will receive interference because SkyBridge Satellites "can be as near in angular separation as the adjacent

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66/ PanAmSat Comments at A-4.

67/ Id. PanAmSat justifies its concern by stating that "slightly less than worst case values of interference are produced at slightly greater percentages of time than the worst case occurrences." Id. PanAmSat ignores the fact that as with any other phenomenon, the time duration corresponding to the short term levels includes the entire time that the interference is higher than the long term limit.

GSOs."[68] This is clearly not the case. Due to the interference mitigation techniques employed by SkyBridge, the minimum angular separation -- 10° -- is five times as great as the standard 2° angular separation between GSO satellites.

2. "Quasi-geostationary" systems.

PanAmSat argues that SkyBridge may preclude the future implementation of any "quasi-GSO" FSS system.[69] Because the subject bands are already occupied by GSO systems that must be protected, introduction of quasi-GSO systems in these bands raises issues similar to those raised by the introduction of any other type of NGSO system. If a quasi-GSO system were to be deployed co-frequency with a SkyBridge-like NGSO system, coordination would have to take place, just as in the case of deployment of another NGSO system. The success of such coordination would depend on a variety of factors.[70]

3. Dimensions of the non-operating zone.

PanAmSat asserts that the dimensions of the $\pm 10°$ non-operating zone deserve further study, but fails to provide any particular reason for doing so.[71] SkyBridge has, of course, performed extensive simulations to assess the appropriate dimension of the non-operating zone, the results of which are summarized below.

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[68] AMSC Comments at 3.

[69] PanAmSat Comments at A-5.

[70] Other than its minimal value as a rather transparent and short-lived distraction, it is difficult to understand PanAmSat's expressed concern for quasi-GSO systems. To SkyBridge's knowledge, PanAmSat has never publicly suggested that it contemplates adopting that technology for its own systems, and with good reason: the commercial viability of such a system is questionable at best.

[71] PanAmSat Comments at 2 and A-3.

SkyBridge's analysis makes it abundantly clear that the SkyBridge avoidance angle is in no way premised on "half-considered theories and unstated, untested - and perhaps unrealistic - assumptions," as PanAmSat alleges.[72/]

The following table indicates the margin (in degrees) that SkyBridge has provided with the $\pm 10°$ non-operating zone:

Band Type	**Service**	**Separation Margin (degrees)**
Planned	FSS	over 5
Planned	BSS	over 2
Unplanned	FSS	2 to over 7

These values have been calculated using standardized earth station patterns and sizes appropriate to the type of band, as well as the interference criteria defined in Exhibit B of the Application. The margins demonstrate the very conservative nature of the $\pm 10°$ non-operating zone, to allow future evolution of GSO systems (both FSS and BSS) and to account for slightly inclined orbit systems.

4. Additional Operation Issues.

PanAmSat's motivation in raising several additional issues about SkyBridge's operation also is not clear. None of these issues has anything to do with the proposed hard limits, or even with the results of SkyBridge's interference analysis.

PanAmSat states that "[i]t would not be unreasonable to require each satellite to 'turn-off' outer spot beams as the satellite approaches its most northerly

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72/ Id.

and most southerly excursion from the equator to in effect reduce an otherwise increased epfd which would occur at higher latitudes."[73/] It is not clear what PanAmSat is trying to say here, but it appears that PanAmSat believes that the protection offered to a GSO receiver is a function of latitude. This is not the case. The SkyBridge System offers the same level of protection for any point on Earth. A SkyBridge Satellite will not serve a Gateway Cell if, as seen from any point within the Cell, the Satellite is less than 10° from a GSO satellite.

PanAmSat further argues that "[i]t would be preferable [PanAmSat does not state for whom] to have a nominal operating mode where the primary sub-constellation would provide service to latitudes between 30° and 60° using only the minimum number of spot beams necessary to provide continuous coverage and to use a satellite from the other sub-constellation when the satellite from the primary sub-constellation crosses through the non-operating zone with respect to the Gateway earth station."[74/] Again, PanAmSat's point is not entirely clear.

If this is a gratuitous suggestion of a way in which SkyBridge might profitably alter its system design, the suggestion is declined; as in demonstrated supra, there are gaps in PanAmSat's understanding of fundamental principles of NGSO operation. If this is a suggestion that such an operational mode should be imposed by the FCC on all NGSO systems, it is absurd, having nothing to do with any legitimate interest of PanAmSat's and being flatly inconsistent with a primary

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[73/] PanAmSat Comments at A-7.

[74/] Id.

resource allocation goal of sharing traffic among all satellites available, regardless of sub-constellation.

Finally, PanAmSat asks how SkyBridge ensures that the operating environment existing at the time a User Terminal is installed will be maintained, and how the SkyBridge System can accommodate new structures that may block line of sight.[75] The issues raised by PanAmSat are the same for any GSO, NGSO, or FS system. New structures can always lead to the need for modification of an installation. The interference analysis is not affected by such concerns; the local environment will not impact the power levels generated by SkyBridge at GSO receivers. As has been explained in both the Application and the Amendment,[76] the User Terminals will not transmit unless receiving a signal from a SkyBridge Satellite, and thus any installation problems or changes in the local environment will not affect other systems.

5. SkyBridge User Terminals.

Tempo claimed that SkyBridge User Terminal operations would need to be coordinated with DBS systems operating in the 12.2-12.7 GHz (downlink) band and the 17.3-17.8 GHz (uplink) band.[77] This statement reflects a fundamental misunderstanding of the interference-avoidance techniques employed by the SkyBridge System. In both bands, frequency reuse between the User Terminals and the DBS systems would be co-directional. In the case of the downlinks, the GSO arc-

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[75] PanAmSat Comments at A-6.

[76] See, e.g., Application at 73.

[77] Tempo Comments at 4.

avoidance method limits the p.f.d. levels from SkyBridge Satellites into GSO earth stations, including DBS receivers, to harmless levels. Adoption of the hard limits proposed in the Petition would ensure that all NGSO systems afford such protection. Furthermore, this protection is completely independent of the number and location of the DBS receivers, so no coordination is necessary.[78/] The same is true in the case of the uplinks. The GSO arc-avoidance technique ensures that the uplink power levels seen at any GSO satellite, including DBS satellites, is of a negligible level, regardless of the number and location of the SkyBridge earth stations. The noise floor computations included in Exhibit C of the Amendment, and discussed further above, demonstrate that DBS systems will be fully protected from interference, without the necessity of any coordination whatsoever.

CONCLUSION

The Petition affords the Commission the opportunity to chart the course for an entirely new generation of satellite systems -- systems that do not require an exclusive reservation of scarce spectrum resources and which can utilize the vast amount of space beyond the GSO orbit that is presently unused. None of the comments received offer any credible reason for delaying consideration of the issues raised in the Petition. The public interest would be greatly served by an expeditious

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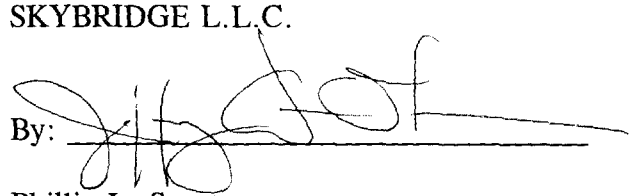
78/ With the SkyBridge System, as with, for example, VSAT networks, interference into DBS receivers can be quantified without knowing the number and placement of the receivers. This is because the parameters of the receivers are known, and the direction they are pointing -- towards the GSO arc -- is known. SkyBridge assumes in its interference analysis that DBS receivers may be located anywhere on earth, and may be pointing at any location along the GSO arc.

rulemaking to permit NGSO FSS systems to operate co-frequency with GSO and terrestrial services at Ku-band, subject to regulations which ensure protection of those services.

Respectfully submitted,

SKYBRIDGE L.L.C.

By: 

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Dated: September 11, 1997

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